Self-reported behavior of eating quickly is correlated with visceral fat area in Japanese non-obese adults

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ABSTRACT

Background and Objectives: This cross-sectional study investigated the relationship between eating speed and fat accumulation in Japanese non-obese adults. **Methods and Study Design:** In total, 381 non-obese participants aged 35–74 years underwent a health checkup including fat distribution. All participants underwent magnetic resonance imaging to quantify visceral fat area (VFA) and subcutaneous fat area (SFA). Information on eating speed was obtained using a self-administrated questionnaire. **Results:** The numbers of participants with self-reported behavior of eating slowly, medium, or quickly were 24 (6.3%), 180 (47.2%), and 177 (46.5%), respectively. The prevalence of VFA ≥100 cm^2 was higher in the eating quickly group than in the eating slowly (p<0.05) or medium groups (p<0.05). On the other hand, no significant differences in SFA ≥100 cm^2 were observed between groups. In addition, multiple stepwise regression analysis showed that eating quickly was positively correlated with VFA (standard β=0.068, p<0.05), but not with SFA. **Conclusions:** Although eating quickly was positively correlated with bigger VFA in Japanese non-obese adults, no associations were found between eating speed and SFA.

Key Words: feeding behavior, intra-abdominal fat, epidemiology, cross-sectional study, Japan

INTRODUCTION

Obesity is a worldwide concern and is closely associated with metabolic diseases.[1-3] In particular, excess accumulation of visceral fat is a central factor in the augmentation of atherosclerosis and metabolic syndrome.[4,5] Body mass index (BMI) (body weight divided by the square of height) is generally used to diagnose obesity.[6] However, excess accumulation of visceral fat itself has been shown to increase the risk of atherosclerosis, irrespective of BMI.[7] In addition, compared with subcutaneous fat, the accumulation of visceral fat has been shown to contribute to the pathogenesis of atherosclerosis and cardiovascular disease.[8,9] These observations indicate that fat distribution should be more important than BMI in terms of the risk of atherosclerosis and metabolic syndrome.

Eating behaviors, including eating speed, have long been of interest as factors that contribute to the development of obesity. A meta-analysis based on 23 published studies showed that the pooled odds ratio associated with eating quickly for the presence of obesity was 2.15 (95% confidence interval [CI], 1.84–2.51).[10] This suggests that eating quickly is positively associated with excess body weight. On the other hand, to our knowledge, only one study has been conducted regarding the relationship between eating speed and fat distribution.[11] Further studies are needed to clarify this relationship.

It is known that visceral fat area (VFA) and subcutaneous fat area (SFA) at the umbilical level strongly correlated to visceral and subcutaneous fat volumes.[12] Therefore, measuring VFA and SFA is popularly used to analyze fat distribution.[7-9] We hypothesized that eating speed would be correlated with fat distribution, even in non-obese people. The purpose of the present cross-sectional study was to investigate the relationship between eating speed and fat distribution in Japanese non-obese adults.

MATERIALS AND METHODS

Study population

The present study was conducted in accordance with the Declaration of Helsinki, and the study protocol was approved by the Ethics Committee of Asahi University (No.27010). A total of 398 participants aged 35–74 years who underwent health checkups were recruited from January 2013 to December 2016 at Asahi University Hospital in Gifu, Japan. Since the present study involves completing a survey, we did not perform sample size calculations. Three participants with missing data were excluded, as were 14 participants classified as obese (BMI ≥30).[6] All participants provided written informed consent prior to enrollment in the study.

Medical examinations

BMI was calculated for each participant, and body weight and height were measured using a body composition meter (Tanita, Tokyo, Japan).[6] Waist circumference (WC) at the umbilical region was also measured. Systolic blood pressure (SBP) and diastolic blood pressure (DBP) were measured using an automatic blood pressure monitor (Omron Healthcare, Kyoto, Japan). Venous fasting blood samples were collected, and serum levels of triglyceride (TG), high-density lipoprotein (HDL) cholesterol, and hemoglobin A1c (HbA1c) were determined using an automatic analyzer (Dimension Vista 1500, Siemens Healthineers Japan, Tokyo, Japan; DM-JACK, Kyowa Medex, Tokyo, Japan). In addition, abdominal fat composition (VFA and SFA) was determined by the standard method using automated computed tomography with a special program for fat area measurement.

Questionnaire

Information on lifestyle factors was assessed using two self-administered questionnaires. One questionnaire included dietary behaviors, and physical activity. Dietary behaviors included eating speed (slow, medium, or fast), dinner within 2 h of bedtime 3 or more times per week (yes/no), eating snacks after dinner 3 or more times per week (yes/no), and skipping breakfast 3 or more times per week (yes/no).[13] Physical activity included regular exercise habits (absence/presence) and walking speed (slow/not slow).

A second questionnaire provided three categories of responses (rarely or never; occasionally, or every day) to describe the participants' frequency of alcohol drinking, consumption of beef or pork, chicken, fish, eggs, confectioneries or sweet snacks, vegetables, fruits, and coffee.[14] The categories for each type of consumption were combined into two categories: not every day and every day. This questionnaire also included items on gender, age, and smoking (Brinkman Index). Brinkman Index represents the number of cigarettes smoked per day multiplied by the number of years of smoking.

Statistical analysis

All measurements and calculated values are presented as medians and interquartile ranges. The chi-square or Kruskal–Wallis test with a post hoc Mann–Whitney U test (corrected Bonferroni method) was used to compare the groups with different eating speeds. Spearman correlation analysis was used to assess the relationship between VFA or SFA and the clinical variables. Independent variables were selected when the p value was <0.20 for the Spearman correlation analysis.[15] Stepwise multiple linear regression analyses were performed to identify the independent predictor of VFA or SFA. Age, gender, smoking status, dietary behavior, and physical activity were selected as adjusted variables. In addition, because the number of participants with self-reported behavior of eating slowly was small (n=24), we combined the categories of eating slowly and eating medium in the correlation and the linear regression analyses. The level of statistical significance was set at $p<0.05$. SPSS (version 24; IBM Japan, Tokyo, Japan) was used to analyze all data.

RESULTS

Table 1 presents the participants' characteristics. About 70% of all participants were men. The median (25%, 75% quartile) age, BMI, VFA, and SFA of all participants were 53 (45, 59) years, 23.2 (21.4, 25.4) kg/m^2, 98 (59, 140) cm^2, and 136 (101, 174) cm^2, respectively. In addition, the numbers of participants with self-reported behavior of eating slowly, medium, and quickly were 24 (6.3%), 180 (47.2%), and 177 (46.5%), respectively. There were significantly differences in Brinkman Index, WC, BMI, and VFA between eating medium and eating quickly ($p<0.05$). Significantly differences in WC, BMI, SBP, DBP, VFA, and SFA between eating slowly and eating quickly groups were also observed ($p<0.05$).

The comparative results of the participants with different eating speeds are shown in Figure 1. The prevalence of VFA $\geq$100 cm^2 was higher in the eating quickly group than in the eating slowly ($p<0.05$) and eating medium groups ($p<0.05$). On the other hand, no significant differences in the prevalence of SFA $\geq$100 cm^2 were observed between the three groups.

Table 2 shows the results of the correlation analyses between VFA or SFA and the clinical variables. VFA values were positively correlated with gender ($r=0.431$, $p<0.001$), age ($r=0.265$, $p<0.001$), Brinkman Index ($r=0.287$, $p<0.001$), WC ($r=0.814$, $p<0.001$), BMI ($r=0.726$, $p<0.001$), SBP ($r=0.369$, $p<0.001$), DBP ($r=0.353$, $p<0.001$), HbA1c ($r=0.306$, $p<0.001$), TG ($r=0.481$, $p<0.001$), eating snacks after dinner ($r=0.125$, $p<0.05$), and eating quickly ($r=0.240$, $p<0.001$), and negatively correlated with HDL cholesterol ($r=-0.461$, $p<0.001$), frequent consumption of confectioneries or sweet snacks ($r=-0.121$, $p<0.05$), and frequent consumption of vegetables ($r=-0.142$, $p<0.01$). SFA values were positively correlated with WC ($r=0.634$, $p<0.001$), BMI ($r=0.635$, $p<0.001$), SBP ($r=0.122$, $p<0.05$), DBP ($r=0.108$, $p<0.05$), HbA1c ($r=0.178$, $p<0.001$), walking speed ($r=0.140$, $p<0.01$), TG ($r=0.224$, $p<0.001$), eating snacks after dinner ($r=0.186$, $p<0.001$), and eating quickly ($r=0.139$, $p<0.01$), and negatively correlated with gender ($r=-0.202$, $p<0.001$), HDL cholesterol ($r=-0.160$, $p<0.01$), and frequent consumption of alcohol ($r=-0.166$, $p<0.05$).

Tables 3 and 4 show the results of the multivariate stepwise regression analysis with VFA or SFA as the dependent variable. VFA values were significantly related to WC (standard $\beta=0.548$, $p<0.001$), TG (standard $\beta=0.121$, $p<0.001$), age (standard $\beta=0.141$, $p<0.001$), gender (standard $\beta=0.126$, $p<0.001$), BMI (standard $\beta=0.139$, $p<0.01$), eating quickly (standard $\beta=0.068$, $p<0.05$), and eating snacks after dinner (standard $\beta=0.060$, $p<0.05$). SFA values were significantly related to WC (standard $\beta=0.605$, $p<0.001$), gender (standard $\beta=-0.531$, $p<0.001$), and BMI (standard $\beta=0.292$, $p<0.001$).

DISCUSSION

This cross-sectional study investigated the relationship between eating speed and VFA in non-obese Japanese adults. The value of VFA for eating quickly showed higher than those for eating slowly and eating medium. We also found that the participants with self-reported behavior of eating quickly had a higher prevalence of VFA $\geq$100 cm^2 compared with those with self-reported behavior of eating slowly or medium. In the stepwise regression analyses, VFA values were positively correlated with eating quickly after adjusting for age, gender, smoking, dietary behavior, and physical activity. Because increased VFA indicates the accumulation of visceral fat, these results suggest that eating quickly is a risk factor for the accumulation of visceral fat in adults. In a previous study, faster eating was positively associated with visceral fat accumulation in apparently healthy Japanese men.[11] In the present study, we found that eating quickly was positively associated with visceral fat size in Japanese adults, independent of obesity.

Some possible mechanisms may underlie the relationship between eating speed and VFA. For instance, energy intake per day has been shown to increase significantly with an increase in the rate of eating.[16] This suggest that fast eaters have increased energy intake. In addition, eating quickly is associated with reduced satiety,[17] suggesting that eating quickly may cause overeating before the stomach can sense fullness. However, further studies are needed to clarify the mechanisms by which eating speed affects visceral fat size.

Numerous studies have investigated the relationship between eating speed and overweight/obesity.[18,19] Eating quickly, compared with eating medium, has been shown to significantly increase the odds ratio for overweight in Japanese boys.[20] Moreover, eating quickly was significantly associated with overweight for Japanese adult men.[21] In addition, in a longitudinal study, the risk of overweight was shown to be higher among Japanese young adults who ate quickly at baseline.[22] These observations are consistent with the findings of the present study that suggest a positive association between eating speed and visceral fat size.

On the other hand, no association was observed between eating speed and SFA, which suggests that eating speed had little effect on subcutaneous fat accumulation. The relationship between eating speed and obesity would be expected to differ according to the type of obesity: visceral or subcutaneous fat. When providing instruction regarding eating speed, it may be necessary to check which type of obesity the individual has.

The results of the present study revealed that eating snacks after dinner was positively correlated with bigger VFA. This indicates that not only eating speed but also timing of food intake could contribute to bigger visceral fat size. This is consistent with the evidence that the consumption of food during the circadian evening and/or night plays an important role in body composition.[23] It has been demonstrated that food intake during nighttime is less satiating and leads to greater daily caloric intake compared with food intake during morning hours.[24,25] Such conditions would contribute to the size of visceral fat. However, it has also been shown that a bedtime supply of nutrients can promote positive physiological changes in healthy populations.[26] Additional studies in populations with various conditions of health and disease are required to clarify the relationship between eating snacks after dinner and visceral fat size.

Bigger visceral fat size has been shown to increase the risk for developing atherosclerosis and metabolic syndrome,[4,5] and the results of the present study suggest that eating quickly and eating snacks after dinner frequently could be a contributing factor via its effects on visceral fat size. It is feasible that eating speed and timing of food intake are controllable risk factors; therefore, regulating these feeding behaviors may be beneficial to decrease the risk of atherosclerosis and metabolic syndrome.

In the present study, we evaluated eating speed (eating slowly, medium, or quickly) using a self-administered questionnaire. This method has been proven effective in previous studies.[11, 27] In addition, a previous study demonstrated that self-reports of eating quickly were related to fewer chews until first swallow, total number of chews, and total duration of chewing.[28] These findings support the validity of using the self-administered questionnaire regarding eating speed used in the present study.

The present study did have some limitations. First, all participants had received health checkups at Asahi University Hospital. This may limit our ability to extrapolate the findings to the general population. Second, the data regarding total energy intake and eating frequency per day may have affected the current associations. However, because our study accompanied health checkups, the data obtained were limited these variables could not be assessed. In the future, it might be necessary to collect the additional data about energy or nutrient intake. Third, the present study had a cross-sectional design, which prevents conclusions regarding causal relationships. Additional longitudinal studies are needed to investigate the relationship between eating speed and VFA.

Conclusions

Eating quickly was positively associated with bigger VFA in Japanese non-obese adults. On the other hand, no association was found between eating quickly and SFA. In non-obese adults, the relationship between eating quickly and fat size differed according to fat distribution.

AUTHOR DISCLOSURE

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Table 1. Comparison of characteristics between participants with different eating speeds (n=381)

Variables	All	Eating speed			*p* value[††]
		Slowly (n=24)	Medium (n=180)	Quickly (n=177)	
Gender [†]	113/268 (70.3%)	11/13 (54.2%)	56/124 (68.9%)	46/131 (74.0%)	0.11
Age (years)	53 (45, 59)	51 (43, 58)	52 (45, 59)	53 (46, 59)	0.48
Brinkman Index	0 (5, 395)	0 (0, 453)	0 (0, 300)[*]	180 (0, 440)	0.03
WC (cm)	81 (76, 86)	75 (71, 81)[*, **]	80 (75, 85)[*]	83 (78, 89)	<0.001
BMI (kg/m^2)	23.2 (21.4, 25.4)	20.7 (18.6, 22.5)[*, **]	22.9 (21.3, 24.6)[*]	24 (21.8, 26.2)	<0.001
SBP (mmHg)	121 (110, 129)	110 (105, 119)[*, **]	120 (110, 128)	124 (110, 131)	<0.01
DBP (mmHg)	75 (67, 83)	67 (65, 75)[*, **]	75 (66, 82)	77 (68, 84)	<0.01
HbA1c (%)	5.4 (5.3, 5.7)	5.4 (5.3, 5.5)	5.4 (5.3, 5.6)	5.5 (5.2, 5.8)	0.21
TG (mg/dL)	76 (53, 107)	78 (47, 107)	76 (50, 111)	76 (54, 107)	0.81
HDL-C (mg/dL)	60 (49, 73)	68 (53, 88)	61 (50, 73)	58 (49, 74)	0.13
VFA (cm^2)	98 (59, 140)	56 (33, 116)[*]	88 (54, 128)[*]	118 (76, 156)	<0.001
SFA (cm^2)	136 (101, 174)	106 (76, 143)[*]	127 (97, 172)	149 (108, 180)	<0.01
Regular exercise habits[‡]	298/83 (21.8%)	21/3 (12.5%)	135/45 (25.0%)	142/35 (19.8%)	0.26
Walking speed [§]	192/189 (49.6%)	13/11 (45.8%)	77/103 (57.2%)	102/75 (42.4%)	0.02
Frequency of dietary consumption[¶]					
Beef or pork	326/55 (14.4%)	22/2 (8.3%)	153/27 (15.0%)	151/26 (14.7%)	0.68
Chicken	353/28 (7.3%)	23/1 (4.2%)	166/14 (7.8%)	164/13 (7.3%)	0.82
Fish	331/50 (13.1%)	24/0 (0.0%)	154/26 (14.4%)	153/24 (13.6%)	0.14
Eggs	250/131 (34.4%)	17/7 (29.2%)	129/51 (28.3%)	104/73 (41.2%)	0.03
Confectioneries or sweet snacks	256/125 (32.8%)	14/10 (41.7%)	120/60 (33.3%)	122/55 (31.1%)	0.57
Vegetables	95/286 (75.1%)	4/20 (83.3%)	47/133 (73.9%)	44/133 (75.1%)	0.60
Fruits	283/98 (25.7%)	18/6 (25.0%)	126/54 (30.0%)	139/38 (21.5%)	0.18
Coffee	91/290 (76.1%)	6/18 (75.0%)	44/136 (75.6%)	41/136 (76.8%)	0.95
Alcohol	315/66 (17.3%)	19/5 (20.8%)	147/33 (18.3%)	149/28 (15.8%)	0.74
Dinner within 2 hours of bedtime 3 or more times per week[‡]	235/146 (38.3%)	15/9 (37.5%)	121/59 (32.8%)	99/78 (44.1%)	0.09
Eating snacks after dinner 3 or more times per week[‡]	293/88 (23.1%)	19/5 (20.8%)	141/39 (21.7%)	133/44 (24.9%)	0.75
Skipping breakfast 3 or more times per week[‡]	330/51 (13.4%)	21/3 (12.5%)	159/21 (11.7%)	150/27 (15.3%)	0.60

WC: waist circumference; BMI: body mass index; SBP: systolic blood pressure; DBP: diastolic blood pressure; HbA1c: hemoglobin A1c; TG: triglyceride; HDL-C: high density lipoprotein cholesterol; VFA: visceral fat area; SFA: subcutaneous fat area.
Continuous variables are expressed as median and interquartile range.
[†]Women/men (percentage of men); [‡]yes / no (percentage of yes); [§]Not slowly/slowly (percentage of slowly); [¶]Not every day/every day (percentage of every day); [††]Chi-square test or Kruskal-Wallis test
[*]*p* <0.05 compared with eating speed quickly groups with Kruskal-Wallis test post hoc Mann-Whitney U test (corrected by Bonferroni methods).
[**]*p* <0.05 compared with eating speed medium groups with Kruskal-Wallis test post hoc Mann-Whitney U test (corrected by Bonferroni methods).

Table 2. Spearman correlation analysis of VFA and SFA

Clinical Variables	VFA		SFA	
	r	*p* value	r	*p* value
Gender[†]	0.431	<0.001	-0.202	<0.001
Age (years)	0.265	<0.001	-0.031	0.543
Brinkman Index	0.287	<0.001	-0.081	0.113
WC (cm)	0.814	<0.001	0.634	<0.001
BMI (kg/m^2)	0.726	<0.001	0.635	<0.001
SBP (mmHg)	0.369	<0.001	0.122	0.018
DBP (mmHg)	0.353	<0.001	0.108	0.035
HbA1c (%)	0.306	<0.001	0.178	<0.001
TG (mg/dL)	0.481	<0.001	0.224	<0.001
HDL-C (mg/dL)	-0.461	<0.001	-0.160	0.002
Regular exercise habits[‡]	-0.034	0.513	0.013	0.801
Walking speed[§]	0.045	0.386	0.140	0.006
Frequency of dietary consumption[¶]				
Beef or pork	-0.054	0.297	0.016	0.750
Chicken	-0.078	0.127	0.077	0.131
Fish	0.039	0.444	0.024	0.645
Eggs	-0.041	0.424	0.029	0.572
Confectioneries or sweet snacks	-0.121	0.018	0.063	0.218
Vegetables	-0.142	0.006	0.013	0.806
Fruits	-0.073	0.155	-0.014	0.788
Coffee	-0.012	0.814	-0.067	0.191
Alcohol	0.004	0.934	-0.166	0.023
Dinner within 2 hours of bedtime 3 or more times per week[‡]	0.051	0.325	0.065	0.206
Eating snacks after dinner 3 or more times per week[‡]	0.125	0.015	0.186	<0.001
Skipping breakfast 3 or more times per week[‡]	0.006	0.904	-0.028	0.588
Eating speed[††]	0.240	<0.001	0.139	0.007

WC: waist circumference; BMI: body mass index; SBP: systolic blood pressure; DBP: diastolic blood pressure; HbA1c: hemoglobin A1c; TG: triglyceride; HDL-C: high density lipoprotein cholesterol; VFA: visceral fat area; SFA: subcutaneous fat area.
[†]Men/women (men); [‡]yes / no (yes); [§]not slowly/slowly (slowly); [¶]not every day/every day (every day); [††]not quickly/quickly (quickly).

Table 3. Factors associated with VFA in the study population by stepwise multiple regression analysis

Dependent variables	Unstandardized coefficients		Standardized coefficients β	*p* value	95% CI for B		VIF
	B	S.E. B			Lower bound	Upper bound	
(Constant)	-357	17.7			-392	-322	
WC	3.79	0.366	0.548	<0.001	3.07	4.51	3.60
TG	0.127	0.027	0.121	<0.001	0.074	0.180	1.15
Age	0.908	0.182	0.141	<0.001	0.549	1.27	1.05
Gender (men)	15.1	3.64	0.126	<0.001	7.94	22.2	1.19
BMI	2.65	0.967	0.139	0.006	0.749	4.55	3.32
Eating speed (quickly)	7.46	3.14	0.068	0.018	1.28	13.6	1.06
Eating snacks after dinner 3 or more times per week (presence)	7.72	3.70	0.060	0.038	0.442	15.0	1.05

Adjusted R^2=0.705.
CI: confidence interval; S.E: standard error; WC: waist circumference; BMI: body mass index; TG: triglyceride; VFA: visceral fat area; VIF: variance inflation factor.

Table 4. Factors associated with SFA in the study population by stepwise multiple regression analysis

Dependent variables	Unstandardized coefficients		Standardized coefficients β	*p* value	95% CI for B		VIF
	B	S.E. B			Lower bound	Upper bound	
(Constant)	-248	17.3		<0.001	-282	-214	
WC	4.49	0.393	0.605	<0.001	3.72	5.26	3.46
Gender (men)	-68.0	3.95	-0.531	<0.001	-75.8	-60.3	1.17
BMI	5.96	1.04	0.292	<0.001	3.91	8.02	3.23

Adjusted R^2=0.705
CI: confidence interval; S.E: standard error; WC: waist circumference; BMI: body mass index; SFA: subcutaneous fat area; VIF: variance inflation factor.

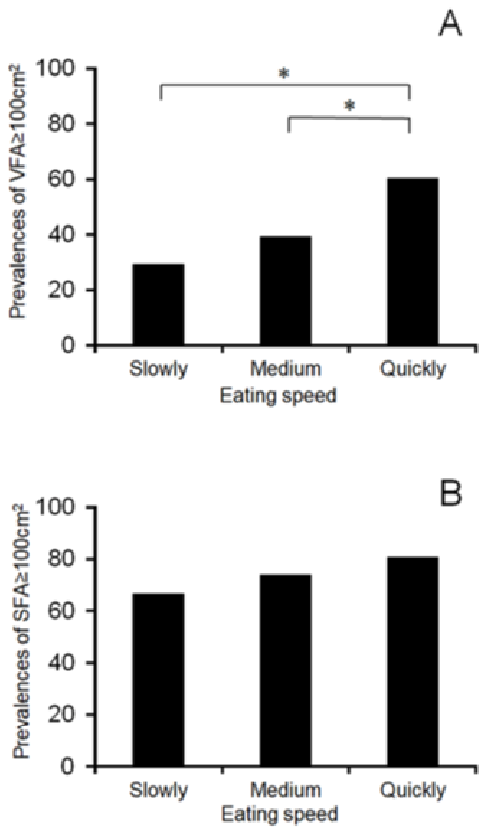

Figure 1. Differences in the prevalence of VFA ≥100 cm^2 (A) or SFA ≥100 cm^2 (B) according to eating speed. VFA: visceral fat area; SFA: subcutaneous fat area. $^*p<0.05$, compared with between-participant groups of each eating speed using the Kruskal–Wallis test with a post hoc Mann–Whitney U test (corrected Bonferroni method).